

and is connected to the connection unit 2 to charge the secondary battery 3 with night period rate electric power. The residual capacity of the secondary battery is determined by subtracting a discharged capacity from an initial capacity. FIG. 9 shows the difference between residual capacity indication and actual residual capacity. As is obvious from FIG. 9, the difference increases as the number of charge and discharge cycles increases and, consequently, accurate residual capacity indication is impossible. FIG. 10 shows the charge and discharge cycle characteristics of batteries. As is obvious from FIG. 10, the capacities of a lead-acid battery, a nickel-cadmium battery, a nickel-metal hydride battery and a lithium battery decrease greatly as the number of charge and discharge cycles increases, and the lives of those batteries are in the range of 500 to 700 charge and discharge cycles.

As is apparent from the foregoing description, according to the present invention, the soundness of the battery can be secured, and charging and discharging are carried out efficiently. The secondary battery can be charged with inexpensive night period rate electric power in the night and the surplus electric power can be supplied to loads in the day time.

What is claimed is:

1. A secondary battery storage system for connection to a power system, the storage system comprising:

- a secondary battery connected to a secondary battery load;
- a detecting device for detecting a residual electric power of said secondary battery;
- a connection unit connected to the power system and to said secondary battery;
- a control unit connected to said connection unit; and
- a signal line for transmitting information about said secondary battery through said detecting device to said control unit, wherein said control unit controls said connection unit on the basis of said information, wherein said information comprises measured values for determining a residual electric power stored in the secondary battery, wherein for discharging the residual electric power said connection unit selects either the secondary battery load or the power system depending on the residual electric power stored in the secondary battery.

2. A secondary battery storage system according to claim 1, further comprising a plurality of loads, wherein the plurality of loads is connected to said connection unit, and said plurality of loads is connected to said signal line, wherein for discharging the residual electric power said connection unit selects at least a load of said plurality of loads depending on the residual electric power stored in the secondary battery, and wherein said information further comprises information about the operating condition of at least one load of said plurality of loads connected to the connection unit.

3. A secondary battery storage system according to claim 1, further comprising a plurality of loads, wherein the plurality of loads is connected to said connection unit, and said plurality of loads is connected to said signal line, wherein for discharging the residual electric power said connection unit selects at least a load of said plurality of loads depending on the residual electric power stored in the secondary battery, and further comprising a plurality of electric power storage units, wherein the plurality of electric power storage units is connected to said connection unit, and the plurality of electric power storage units is connected to said signal line, wherein for discharging the residual electric

006011" 29580460

CM

16

power said connection unit selects at least a unit of said plurality of electric power storage units depending on the residual electric power stored in the secondary battery, wherein said information further comprises information about the operating condition of at least one load of said plurality of loads and the operating condition of at least one electric power storage unit of said plurality of electric power storage units.

4. A secondary battery storage system according to claim 1, further comprising a plurality of electric power storage units, wherein the plurality of electric power storage units is connected to said connection unit, and said plurality of electric power storage units is connected to said signal line, wherein for discharging the residual electric power said connection unit selects at least a unit of said plurality of electric power storage units, depending on the residual electric power stored in the secondary battery, wherein said information further comprises information about the operating condition of at least one unit of said plurality of electric power storage units.

5. A secondary battery storage system according to claim 3, wherein said secondary battery and said secondary battery load connected to the secondary battery are separable.

6. A secondary battery storage system according to claim 1, wherein said control unit comprises a computer and wherein the computer measures the amount of electric power charged into the secondary battery and the amount of electric power discharged from the secondary battery, and calculates the amount of residual electric power stored in the secondary battery.

7. A secondary battery storage system according to claim 1, wherein said control unit comprises a computer and wherein the computer measures the amount of electric power charged into the secondary battery and the amount of electric power discharged from the secondary battery, and calculates the amount of residual electric power stored in the secondary battery, and an indicating unit indicates the amount of residual electric power calculated by the computer.

8. A secondary battery storage system according to claim 1, wherein the secondary battery comprises a battery selected from the group consisting of a lead-acid battery, a lithium battery, a nickel-cadmium battery and a nickel-metal hydride battery.

9. A secondary battery storage system according to claim 3, wherein the charge/discharge unit comprises: a dc-ac conversion means, and a switching means for selectively connecting the power system to the secondary battery, the plurality of loads or the plurality of electric power storage units.

10. A secondary battery storage system according to claim 3, wherein the plurality of electric power storage units comprises at least a battery selected from the group consisting of lead secondary batteries, lithium secondary batteries, nickel cadmium secondary batteries, nickel-metal hydride secondary batteries, heat storage and heat exchanger type electric power storage systems and superconducting type electric power storage systems.

11. A secondary battery storage system for connection to a power system, the storage system comprising:
 a secondary battery connected to a secondary battery load;
 a connection unit connected to the secondary battery, said connection unit connected to the power system and either a plurality of loads or a plurality of electric power storage units;
 a detecting device for detecting a residual electric power in the secondary battery; and

09708562 110900

17

a control unit for controlling the connection unit on the basis of information from the secondary battery and at least one of the loads of the plurality of loads or at least one of the units of the plurality of electric power storage units, wherein for discharging the residual electric power said connection unit selects at least a load of said plurality of loads or a unit of said plurality of electric power storage units depending on the residual electric power stored in the secondary battery, wherein a controller receives information from at least either the secondary battery or the plurality of loads and controls the connection unit; a computer that measures the amount of electric power charged into and the amount of electric power discharged from the secondary battery, calculates the amount of residual electric power stored in the secondary battery, and comprises a memory for storing measured data of the secondary battery and arithmetic program information, and a controller for processing the information stored in the memory or information given thereto from external devices, and an analog-to-digital converter through which information provided by the external devices is given to the controller.

12. A secondary battery storage system according to claim 11, wherein the secondary battery, the computer and the analog-to-digital converter are integrated.

13. A secondary battery storage system according to claim 11, further comprising: measuring means for measuring data on discharge history including discharge current data, discharge voltage data and discharge temperature data and on charge history including charge current data, charge voltage data and charge temperature data; and a computer that receives information from the measuring means.

14. A secondary battery storage system according to claim 11, wherein the memory stores information on a charging method specifying at least one of the intrinsic characteristics of the secondary battery including charging efficiency, discharging efficiency and temperature characteristic, and optimum charge conditions including a maximum charge capacity, a charge current, a charge time, a charge voltage and an upper limit voltage, and information on discharging method specifying at least one optimum discharge condition including a maximum discharge capacity, a discharge current, a discharge time, a discharge voltage and a lower limit voltage.

15. A secondary battery storage system according to claim 11, wherein the memory stores an arithmetic program for determining discharge capacity by integrating discharge current data given to the analog-to-digital converter, wherein the arithmetic program determines charge capacity by integrating charge current data, and determines a converted charge capacity by converting charge capacity in a real-time mode into available capacity at a discharging rate and a temperature condition when the discharge current data is received on the basis of a discharging efficiency and a temperature characteristic stored in the memory, and wherein a program calculates and indicates a residual capacity in a real-time mode by subtracting the discharge capacity determined in a real-time mode from the converted charge capacity determined in a real-time mode.

16. A secondary battery storage system for connection to a power system, the storage system comprising a connection unit connected to the power system, and connected to at least either a plurality of loads or a plurality of electric power storage units and having connecting means to connect the connection unit to a secondary battery; wherein the connection unit is controlled by a controller on the basis of

09708562 110900

18

information received from the plurality of loads or the plurality of electric power storage units, and wherein for discharging a residual electric power of said secondary battery said connection unit selects at least a load of said plurality of loads or a unit of said plurality of electric power storage units depending on the residual electric power stored in the secondary battery, further comprising an information transmitting means for interconnecting the controller and at least either the connecting means or the plurality of loads connected to the connection unit.

17. A method of operating a secondary battery storage system for connection to a power system, the storage system comprising:

- a secondary battery connected to a secondary battery load;
- a detecting device for detecting a residual electric power of said secondary battery;
- a connection unit connected to the power system and to said secondary battery;
- a control unit connected to said connection unit; and
- a signal line for transmitting information about said secondary battery through said detecting device to said control unit;

the method comprising:

- selecting the power system for discharging a residual electric power of the secondary battery through the connection unit after an electric power stored in the secondary battery is discharged to the secondary battery load, depending on the residual electric power stored in the secondary battery.

18. A method of operating a secondary battery storage system for connection to a power system, the storage system comprising: a secondary battery connected to a secondary battery load, and a connection unit connected to the power system and connected to at least either a plurality of loads or a plurality of electric power storage units; the method comprising:

- feeding surplus electric power from the secondary battery to at least either a load of the plurality of loads or a unit of the plurality of electric power storage units, depending on the residual electric power of the secondary battery, prior to charging said secondary battery with power from the power system.

19. A method of operating a secondary battery storage system according to claim 18, further comprising selecting a power receiving object and determining a feed power capacity on the basis of information about at least one of the surplus electric power stored in the secondary battery, the operating condition of the plurality of loads, or the electric power storage condition of the plurality of electric power storage units; and feeding the surplus electric power to the selected power receiving object.

20. A method of operating a secondary battery storage system according to claim 19, wherein the power receiving object is selected and the power feed capacity is determined on the basis of the information about the surplus electric power stored in the secondary battery, the operating condition of the plurality of loads, and the electric power storage condition of the plurality of electric power storage units, after charging the secondary battery through the charge/discharge unit.

21. A method of operating a secondary battery storage system according to claim 18, further comprising determining the operating condition of the plurality of electric power storage units after charging the secondary battery, and selecting a power receiving object on the basis of surplus electric power remaining after feeding residual electric

power to the secondary battery load from the secondary battery; and feeding electric power through the charge/discharge unit to at least one unit of the plurality of electric power storage units.

22. A method of operating a secondary battery storage system according to claim 18, further comprising charging the secondary battery through the charge/discharge unit; selecting a power receiving object and determining power feed capacity on the basis of surplus electric power stored in the secondary battery after feeding electric power to the secondary battery load, determining the power storage condition of the plurality of electric power storage units or the operating condition of the plurality of loads; and feeding electric power from the secondary battery through the charge/discharge unit to the selected power receiving object.

23. A method of operating a secondary battery storage system according to claim 18, wherein the secondary battery storage system is provided with a memory connected with the secondary battery, wherein the method further comprises storing at least optimum discharge conditions for the secondary battery beforehand in the memory, and feeding the surplus electric power of the secondary battery through the charge/discharge unit in a mode conforming to the optimum discharge conditions.

24. A method of operating a secondary battery storage system according to claim 18, further comprising determining the available discharge capacity or the possible discharge time of the secondary battery for the next discharge cycle, estimated on the basis of the past discharge capacity or the past discharge time and change of the discharge capacity, and discharging surplus electric power through the charge/discharge unit according to the estimated available discharge capacity or the estimated possible discharge time.

25. A method of operating a secondary battery storage system according to claim 18, wherein the secondary battery storage system is provided with a memory connected to the secondary battery, and wherein the method further comprises storing at least information about optimum charge conditions for the secondary battery beforehand in the memory, and charging the secondary battery through the charge/discharge unit in a mode conforming to the stored optimum charge conditions after discharging the surplus electric power from the secondary battery.

26. A method of operating a secondary battery storage system according to claim 18, further comprising estimating an available discharge capacity of the secondary battery for the next discharge cycle, after discharging the surplus electric power on the basis of the past charge capacity or charge time and change in the charge capacity, and charging the secondary battery through the charge/discharge unit in a mode conforming to the estimated charge condition.

27. A method of operating a secondary battery storage system according to claim 18, further comprising storing the charge capacity of the secondary battery in a memory, and estimating the future available discharge capacity and the cycle life of the secondary battery on the basis of the change of the charge capacity in the past charge and discharge cycles.

006077 2980760

20

28. A method of operating a secondary battery storage system according to claim 18, wherein the secondary battery is at least either a nickel-cadmium battery or a nickel-metal hydride battery, and the method further comprises discharging an amount of electric power in the range of 95% to 100% of a discharge capacity which can be discharged in a mode conforming to the optimum discharge conditions among the available discharge capacity for the next discharge cycle of the secondary battery as surplus electric power, when the residual capacity is in the range of 0% to 85% of the charge capacity.

29. A method of operating a secondary battery storage system according to claim 18, wherein the secondary battery is a lithium battery, and the method further comprises discharging an amount of electric power in the range of 80% to 95% of a discharge capacity which can be discharged in a mode conforming to the optimum discharge conditions among the available discharge capacity for the next discharge cycle of the secondary battery as surplus electric power, when the residual capacity is in the range of 5% to 80% of the charge capacity.

30. A method of operating a secondary battery storage system according to claim 18, further comprising feeding residual electric power from the secondary battery to the secondary battery load, wherein said feeding surplus electric power further comprises discharging surplus electric power through the connection unit from the secondary battery after said feeding residual electric power from the secondary battery to the secondary battery load, stopping said discharging of the surplus electric power while the secondary battery still comprises residual electric power, and charging the secondary battery to a charge capacity of a preceding charge cycle.

31. A secondary battery storage system for connection to a power system, the storage system comprising:

- a secondary battery connected to a secondary battery load;
- a detecting device for detecting a residual electric power of said secondary battery;
- a connection unit connected to the power system and to said secondary battery; and
- a signal line for transmitting information about said secondary battery through said detecting device to said connection unit, wherein said connection unit controls charging and discharging of the secondary battery on the basis of said information, and wherein said information comprises measured values for determining residual electric power stored in the secondary battery, wherein for discharging the residual electric power said connection unit selects either the secondary battery load or the power system depending on the residual electric power stored in the secondary battery.

* * * * *

32. A method of operating a secondary battery system, the system comprising:

a secondary battery that can charge and discharge;
a charge/discharge unit connected to a power system and to the secondary battery;
a control unit connected to the charge/discharge unit;
and
a signal line connected with the charge/discharge unit and at least one of a load and an electric power storage unit;

the method comprising:
inputting at least one of an information of surplus electric power of the secondary battery, an information of the load, and an information of the electric power storage unit into the control unit; and
controlling by the charge/discharge unit a discharging of the secondary battery.

33. A method of operating a secondary battery system according to claim 32, wherein the secondary battery charges electric power during night period rate hours at night and discharges electric power during day period rate hours at daytime.

34. A method of operating a secondary battery system according to claim 32, wherein the secondary battery charges through the charge/discharge unit and/or discharges through the charge/discharge unit.

22

35. A method of operating a secondary battery system according to claim 32, wherein information is stored in a memory which is part of the secondary battery or which is connected to the secondary battery of discharging of the secondary battery and/or charging of the secondary battery.

36. A method of operating a secondary battery system according to claim 35, wherein information is further stored in the memory of at least one of a charging capacity of the secondary battery, a possible discharging capacity of the secondary battery and/or a life of the secondary battery predicted by the change of the charging capacity.

37. A method of operating a secondary battery system for illumination, the system comprising:

a secondary battery that can charge and discharge;
a charge/discharge unit connected to a power system and to the secondary battery; and

a signal line connected with the charge/discharge unit and a load for illumination;

the method comprising:

controlling discharging of the secondary battery in accordance with information of the load for illumination.

38. A method of operating a secondary battery system for illumination according to claim 37, wherein the charge/discharge unit or a control unit has a timer which controls charging and/or discharging time of the secondary

battery.

39. A method of operating a secondary battery system of an electric vehicle, the system comprising:

a secondary battery that can charge and discharge;

a charge/discharge unit connected to a power system and to the secondary battery; and

a signal line connected with the charge/discharge unit and a load of the electric vehicle;

the method comprising:

controlling discharging of the secondary battery by information of the load of the electric vehicle.

24